Sewer Overflows in Wisconsin –

A Report to the Natural Resources Board

Wisconsin Department of Natural Resources

March 15, 2001

Executive Summary

Over the past 25 years, Wisconsin communities have invested $3.9 billion in improving sanitary sewage collection and treatment systems they own and operate. These improvements range from the replacement of failing on-site disposal systems by small rural communities to the massive Water Pollution Abatement Program in the Milwaukee area. These projects have resulted in significant improvements in the quality of the state's waters.

Due to expanding populations, an aging of this important infrastructure, and several unusual rainfall events in parts of the state, there has been significant public, legislative and media interest in the number of sewage overflows reported in 1999 and 2000. This report contains information that will be used by the Department of Natural Resources in moving forward with actions that seek to prevent, to the maximum extent practicable, the discharge of untreated sewage to state waters.

This report contains information about sanitary sewer and combined sewer systems in the state. It also contains data on the frequency and location of sanitary and combined sewer overflows, and provides additional detail on the sewerage system owned and operated by the Milwaukee Metropolitan Sewerage District.* Most importantly, the report contains a series of recommendations for actions to be taken by the Department, by communities across the state, by the Milwaukee Metropolitan Sewerage District (MMSD) and by the communities served by the MMSD. These recommendations can be summarized as follows:

1) The Department must implement improved systems for tracking and follow-up on reports of sanitary sewer overflows (SSOs). Rules and compliance activities that were developed over the years have produced a patchwork of requirements that need to be consolidated and refined for the sewerage systems in operation in the state. Any new or revised rules must include uniform standards for the design of sewage conveyance and treatment facilities. The Department must create a comprehensive system that will assure:

   a) Sewage collection systems are maintained, operated and managed to prevent the entry of groundwater infiltration and stormwater inflow to the extent practicable and

   b) Infiltration and inflow that enters sewage collection systems does not cause or contribute to SSO.

2) The Department must initiate an outreach program to assure that all communities submit timely reports about SSOs from their sewer systems as required by their WPDES permits, and become more aggressive in correcting the root causes of overflows, particularly excessive infiltration and inflow.

3) Communities in the service area of the Milwaukee Metropolitan Sewerage District must, together with the District, identify and remove the sources of infiltration and inflow to their sanitary sewers so they do not overflow directly to surface waters and, further, assure that the downstream capacity of the District's conveyance, storage and treatment systems are not exceeded.

* MMSD has planned construction projects worth $919 million that are designed to greatly reduce the potential for separated or combined sewer overflows.

4) The Milwaukee Metropolitan Sewerage District must continue to improve the operation of its conveyance, storage and treatment facilities to maximize the amount of combined and sanitary sewage that is captured, stored and treated before discharge to surface waters. MMSD must also work with its contract and service communities to design and implement cost-effective ways to significantly reduce the excessive infiltration and inflow that currently enters local sewers that are tributary to the District's system. In addition, MMSD must prepare a new facilities plan for the period 2010 to 2020 that identifies projects that are needed to upgrade conveyance, storage and treatment to assure SSOs are prevented and CSOs are minimized.

Water quality impairments are caused by many different sources of contamination. Control of any one source of contaminants will not, by itself, address all the water quality problems in a particular river or lake. It is important that the Department continue to investigate these impairments using an integrated, multidisciplinary approach to assure water quality improvements are achieved in a comprehensive manner, using a watershed approach to manage the quality of our waters.

Table of Contents

Introduction

Starting in 1999, citizen interest, media reports and a series of unusually heavy rainfall events have called attention to overflows of sewage to surface waters. These incidents have occurred throughout the state, but due to the large size and unique character of the sewerage system serving the Milwaukee metropolitan area, the focus of attention has been directed primarily to that part of the state. As the scope of the discharge incidents became more widely known, members of the legislature also expressed interest in this issue.[1] Meanwhile, at the federal level, the U.S. Environmental Protection Agency(U.S. EPA) has been developing revisions to federal regulations that govern overflows of sewage from publicly-owned sewerage systems. Additionally, federal enforcement officials U.S. EPA began asking for information on whether Wisconsin's response to the overflow incidents that were being reported is consistent with current federal regulations.

This report will provide a summary of the current situation related to sanitary sewer overflows and combined sewer overflows in Wisconsin. While particular emphasis will be directed toward the Milwaukee area, the issue is of statewide significance. Most importantly, this report will provide a framework for additional state actions needed to control these discharges, assure water quality protection and minimize risks to public health.

Background

Over the past 25 years, communities in Wisconsin have engaged in over 2,500 projects for the construction and improvement of sewage treatment facilities. These facilities have resulted in significant improvements in water quality and have also lessened the public health risks and environmental impacts associated with the discharge of inadequately treated sewage to streams, lakes and groundwater. In some instances, sewage collection systems were constructed to replace failing on-site systems that were over-flowing to surface water or contaminating groundwater. New sewer construction continues to be built to serve the growing population and businesses in the state. Seeking to protect this investment in clean water, Wisconsin's unique compliance maintenance program is designed to assure all communities are providing the needed review of, planning for and improvements to the state's sewerage system infrastructure.

Sewers collect wastewater from homes, commercial establishments and industry and transport it to treatment facilities. In this report, the word "sewage" will be used to describe all wastewater that is discharged to and collected in the sewerage system. Because these systems are designed for certain conditions, based on contemporary engineering practice, there may be instances where these sewers fail or no longer fully function as intended. When sewage cannot flow in the sewer due to a blockage of some type or when the amount of water that enters the system is too large, then the system will overflow onto the ground or into a surface water. Such overflows of sewage into surface waters create a potential health risk for people, and may cause other water quality impairments. In many instances, the sewage will also backup into basements causing property damage in addition to creating potential adverse health effects.

[1] On July 6, 2000, the Assembly Environment Committee held a hearing in Greenfield, WI to gather information on recent overflow events in the Milwaukee area.

Impacts of Sewer Overflows

Why are people concerned about the discharge of sewage from separated sewer overflows (SSOs) and/or combined sewer overflows (CSOs)? The discharge of untreated sanitary sewage directly to surface waters creates several adverse water quality impacts, including a risk to human health, effects on fish and other aquatic life, and other aesthetically objectionable conditions. Pollutants include solids, oxygen-demanding materials, toxic substances and nutrients. Bacteria, viruses and other microorganisms in sewage may transmit disease to people who ingest or are otherwise exposed to waters that contain large quantities of these organisms. State and federal laws and regulations are intended to prohibit the discharge of sanitary sewage without treatment and are designed to minimize such public health risks.

It is important to remember that sewer overflows are only one of many sources of water quality impairment. Nonpoint sources such as runoff from agricultural land and stormwater from urban areas, other point sources, contaminated sediments and contaminants in rainfall all contribute substances that may be harmful to plants and animals that live in and use the water. Appendix A contains information on the levels of various constituents in wastewater and waterways. The list of substances is only a partial list of the many constituents that are present in the discharges from the various types of sources. Overall, nonpoint sources are one of the greatest threats to water quality[2] impairment in the state. However, episodic events such as those from SSOs may also cause localized impairments to water quality.

Design of Sewer Systems

Sewer systems are elements of urban infrastructure that are essential to the protection of public health and welfare. Every community generates water-borne wastes of domestic, commercial, and industrial origin and experiences stormwater runoff. Definitions for frequently used terms are necessary to understand the various aspects of the overflow issue.

Storm Sewers

Storm sewers are designed to convey stormwater runoff and snow-melt to streams and waterways to prevent flooding. Domestic, commercial and industrial wastewater should be excluded from storm sewer systems. Connections to storm sewers include catch basins from streets and parking lots, downspouts from roofs and other drains. Urban storm water originates as runoff from streets and roofs, commercial and industrial facilities, construction sites, and open spaces. This runoff contains contaminants such as bacteria, suspended solids, heavy metals, oil and grease.

Separated Sanitary Sewers

Sanitary sewers are intended to carry the sewage from residences, commercial buildings, industries, and institutions together with “minor” quantities of groundwater and storm runoff that leak into the sewers, but are not intentionally allowed into these sewers.

Sanitary collector sewers are those sewers that have direct connections from the buildings being served. Separated sanitary collector sewers are typically designed based on a per

[2] Source: The State of the Natural Resources, WDNR, Earth Day, 2000 (PUB-CE-270 00)

capita flow rate for residential areas or on the basis of a flow per acre of service area for commercial and industrial zoned areas. An allowance for groundwater infiltration is normally added to the base sewage flow.

Interceptor sewers are those sanitary sewers that transport the flow from the collector sewers to the treatment facility. Interceptor sewers are designed based on peak wet weather flows that have been measured or estimated. Therefore, in some instances, interceptor sewers are sized to convey larger quantities of groundwater infiltration and/or stormwater runoff inflow (I/I), as well as sanitary sewage, that is anticipated will find its way into the sanitary sewer system.

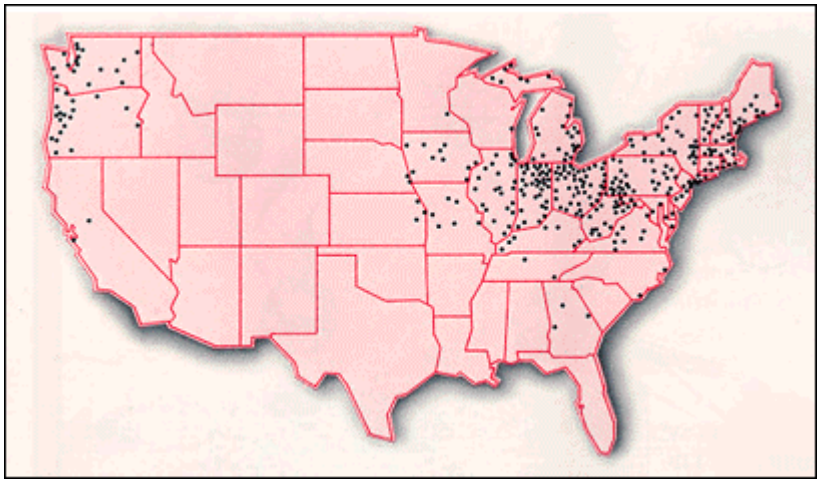
When a sewer system has insufficient capacity to transport the sewage and I/I entering the sewers, the system will relieve itself by discharging the excess flow, a sanitary sewer overflow (SSO) in one of several ways. Sewage may back up into basements through the building sewer. Basement backups can cause extensive property damage and pose a public health threat. Sewage may also be intentionally or unintentionally discharged to the surface. For example, sewage overflowing from a manhole is an example of an unintentional discharge. Alternatively, sewage may be intentionally discharged, usually into surface waters, through a gravity overflow structure or a portable or permanently installed pump.

Combined Sewers

Combined sewers are designed to carry both sewage and storm water runoff. In addition to collecting the sewage that is carried by the sanitary sewage system, a combined sewer system will have street catch basins, downspouts, foundation and other drains directly connected to the sewer. During dry-weather periods the combined sewer functions to carry only sewage to an interceptor sewer and then on to a treatment plant. During wet-weather, the combined sanitary and stormwater are conveyed for treatment until the capacity of the interceptor sewer is exceeded. When the combined sewer or interceptor capacity is exceeded, the excess flow (a combination of sewage and stormwater) is by design discharged to a lake or stream. This discharge is called a combined sewer overflow (CSO).

The first sewers constructed in Wisconsin from about 1870 through 1920 were all combined sewers. As treatment of sewage became more common, separated sewer systems were more commonly constructed to limit flows to treatment plants. By 1977, most of the smaller combined sewer systems in Wisconsin had been replaced with separated systems. Currently, Wisconsin has only three combined sewer systems: portions of the City of Superior and portions of the City of Milwaukee and the Village of Shorewood that discharge to the Milwaukee Metropolitan Sewerage District.

Combined sewer systems remain in common use in many older municipal systems in the United States. The United States Environmental Protection Agency (U.S. EPA) estimates that 950 cities in the US serving over 40 million people have combined sewers. The figure below, copied from a U.S. EPA web site, shows the distribution of known combined sewer systems.



Sewer Construction Materials

Common materials used in sewer construction include cast iron, concrete, vitrified clay and, more recently, various types of plastic pipes. Older construction methods included brick.
Watertight pipe joints are essential for limiting infiltration of groundwater into sewers. In older sewers, bituminous or cement mortar joints were common. These materials did not provide reliable joints. Modern construction joints, including gasketed mechanical connections and solvent weld or heat fused joints, provide better control of leakage. Manholes have been constructed of brick, concrete block and cast-in-place concrete. Currently, pre-cast concrete segments are used for most manhole construction.

Connections as a Source

Because sanitary sewers are normally built below ground, these sewers are susceptible to the intrusion of rainwater and groundwater through sewer cracks and joints. These “leaks” in the system, allowing relatively clean water to enter, cause the flow to increase substantially. If system capacities are too small, basement backups and/or bypasses and overflows will result. In addition to the leakage at joints in the sanitary sewers, there are other sources of infiltration/inflow into these systems.

Pipes called “laterals” are the connections between individual buildings and the sewers, the latter of which are usually located in the street. These laterals are designed to carry sewage from the building plumbing system to the sewers. However, like sanitary sewers, these laterals may be significant sources of clear water. Cracks, age, type of material and poor construction all may be responsible for creating places that water in the soil can enter the lateral.

Another source of water to the sanitary sewers in some cities is roof leaders or downspouts. In some cases, these downspouts are directly connected to the house lateral and carry rainfall that falls on roof surfaces into the sanitary sewers. The primary reason these connections are allowed is the lack of pervious area in more densely developed areas. Additionally, directing downspouts to driveways and sidewalks creates a safety hazard in the winter.

A third connection to sanitary sewers that creates a source of I/I are foundation drains. These drains are installed to prevent groundwater accumulation around a building foundation that leads to leakage of such water into the building basement. In some cases, these drains are needed where the ground water table (either seasonally or permanently)

is above the base of the foundation. In other cases, foundation drains collect water that falls on the ground surface (or from downspouts, for example) and flows into the more pervious soils around the foundation. In more recent construction, foundation drainage is usually collected in a basement sump and pumped to the ground surface away from the building or discharged to a storm sewer.

Combined and Sanitary Sewer Overflows

During dry weather and minor rainfall events, combined sewers transport sewage to a treatment facility. When larger rainfall events occur, the stormwater that enters the sewers is greater than the system can transport and, as noted above, the combination of stormwater and sanitary sewage is by design discharged directly to state waters.

SSO may be discharged directly or indirectly (via a storm sewer) to groundwater and/or to surface waters under two circumstances. First, if an excessive amount of stormwater or other I/I enters a sanitary sewer or if there is more sewage entering a pipe than the pipe can carry, then a SSO may also occur. SSOs may occur via constructed overflow pipes, via other openings in the sanitary sewers, or the system owner may operate portable pumping equipment to remove sewage from the system. The term SSO does not include bypasses or diversions that occur after the sewage has entered a treatment facility and received some level of treatment. SSO only includes those discharges that occur from sanitary sewer systems.

Secondly, overflows are also caused by mechanical, structural or electrical problems in the sewerage system. Sewers may become plugged or blocked with debris, grease, roots or other material. In most instances these blockages create backups in basements and sewer cleaning eliminates the actual occurrence of or potential for an overflow. Similarly, collapsed sewers create an overflow or backup situation. Electrical failures at pump stations do not allow sewage to be pumped downstream in the system and may result in an overflow. Most lift stations are now required to have a second source of power, but that is not always the case for older systems.

Effects of excess water in sanitary sewers

There are basically two ways to deal with excessive amounts of water in a sanitary sewer system; either “transport and treat” both the sewage and the excess I/I, or eliminate the source of the I/I. If one or both of these alternatives are not implemented in a particular system, then the consequences may be one or more of the following:

1) Basement backups – When the sewers are of insufficient size to carry all the water and sewage,[3] they may surcharge and back up into basements of buildings. Such incidents usually cause significant property damage, are a nuisance, and a direct health hazard. Because of the direct effect on sewer system users, municipalities usually do whatever possible to avoid basement backup of sanitary sewage.

2) Sanitary sewer overflows – These overflows may occur when sewers are too small for all the water and sewage that is discharged into them. In many instances, an overflow option is employed (e.g., using portable pumping equipment) rather than allowing sewage to back up into basements. In other instances, depending on the layout of the sewer system, the overflow may happen if a manhole is surcharged and the cover is dislodged causing sewage to flow across the land or in the street to a near-by stream or stormwater collection area. Some lift stations may have pipes that allow

[3] Basement backups may also occur if sewers or laterals become plugged or as a result of mechanical or structural failures in certain situations.

overflows of water levels that are too high and threaten the equipment. Not all sewage from an overflow reaches surface water. Sometimes sewage may accumulate in surface depressions or infiltrate to the groundwater. As with discharges to surface waters, health risks associated with such discharges are apparent.

3) Hydraulic overloading of treatment plants – In many communities, the sanitary sewers, particularly the interceptors, are large enough to transport sewage and significant amounts of I/I that enters the sewer system to the treatment plant. If, however, the treatment plant is hydraulically too small, then bypassing may occur at that point. The excess water/sewage may be diverted around certain treatment units or it may simply over-top the structures, flow over the land surface and to a stream. Treatment facility design normally accounts for all but the most severe events.

Bypasses at Treatment Plants

The term "bypass" has been used to describe several different approaches for routing flows at a sewage treatment plant. A bypass can occur when flow is diverted before it receives any treatment, such as from a sewer system or at a treatment plant upstream of the treatment units. The term "bypass" is sometimes also used to describe an "in-plant" diversion where some flow is routed around some of the units within a treatment plant. The term "controlled diversion" is the term used in Wisconsin rules to describe this type of bypass. In s. NR 110.03(20), Wis. Adm, Code, controlled diversion is defined as follows:

> *"Controlled diversion" means the discharge of untreated or partially treated wastewater around the entire sewage treatment facility, or treatment processes therein, which is recombined with the treated effluent prior to the effluent sampling location.*

The rule that establishes the design criteria for sewerage systems in the state (NR 110, Wis. Adm. Code, encourages the construction of controlled diversions in lieu of bypass structures [s. NR 110.15(2)(e)]. One example of a controlled diversion is when a portion of the primary effluent is diverted around the secondary treatment facilities and discharged into the chlorine contact chamber. The need for diversion or bypass structures, most often to prevent the washout of biomass and accompanying loss of treatment capability and to prevent severe property damage, is also recognized in the rule and is considered sound engineering practice. All flows that are discharged from the facility are measured and monitored.

State Regulations and Permit Requirements

Prohibitions

At a minimum, the discharge of sanitary sewage from a treatment works must meet secondary treatment effluent limits as defined in NR 210, Wis. Adm. Code. More stringent water quality based effluent limits may apply if needed to meet applicable water quality standards. These limitations are specified in a WPDES permit issued to the owner of the treatment facility. If sewage is discharged prior to the sewage reaching the treatment works, then the provisions in NR 205 apply.

Prior to 1998, permits issued for municipal treatment plants contained the following requirement under the standard condition titled "unschedule bypassing":

Discharges reported under this paragraph are not authorized by this permit and the department may initiate legal action regarding such discharges. Action is authorized by s. 147.29 (now s. 283.89), Stats.

Permits issued prior to 1998 also contained the following standard condition:[4]

Unscheduled bypassing. Any unscheduled diversion or bypass of wastewater at the treatment work or collection system is prohibited except in the following cases:
1. An inadvertent bypass resulting from equipment damage or temporary power interruption;
2. An unavoidable bypass necessary to prevent loss of life or severe property damage; or
3. A bypass of excessive storm drainage or runoff which would damage any facilities necessary for compliance with the effluent limitations and prohibitions of the permit. In the event of an unscheduled bypass, the permittee shall immediately notify the department district office by telephone within 24 hours after an occurrence. In addition, the permittee shall notify the department by letter within 5 days after each such unscheduled diversion or unscheduled bypass. The written notification shall at a minimum include reasons for such unscheduled bypass including dates, length of bypass and steps taken or planned to correct and eliminate such occurrences. (s. NR 205.07, Wis. Adm. Code)

Beginning in 1998, permits issued for municipal treatment plants contain only the latter standard condition stated above. This change resulted from the inadvertent deletion of the aforementioned SSO discharge prohibition paragraph from NR 205 when the rule was revised in 1995.

However, there is still a basis for prohibiting the discharge of SSO in permits through the application of the provisions of NR 210, Wis. Adm. Code, which requires discharges from separated sewer systems and treatment plants to at least meet secondary treatment standards. Reinstatement of this provision of NR 205 will be made through a rule revision as soon as possible to avoid confusion about the importance of this requirement and to assure its consistent application in all permits.

In addition to the "unscheduled bypassing" standard condition in permits, NR 205.07(1)(v), Wis. Adm. Code, contains provisions for "scheduled bypassing". This paragraph of the rules is also incorporated into the standard conditions of permits and is intended for use when the permittee needs approval for an overflow during construction or maintenance work at a treatment plant or in a collection system. Prior Department approval is needed, and these events are usually infrequent and of short duration.

All violations of permit conditions are subject to enforcement under the Department's long-standing stepped enforcement process. Initial contacts (primary enforcement) by field staff are made if the overflow event requires an enforcement response (in most instances the corrective action has been implemented before the report is submitted). Secondary enforcement may be initiated if the permittee fails to correct the problem in a timely fashion. Secondary enforcement includes, as a first step, a formal notice of violation sent to the permittee and the scheduling of an enforcement conference or meeting with the facility. If the matter remains unresolved after these steps are completed, subsequent steps may include referral of the matter to the Department of Justice (Attorney General) for appropriate legal action.

[4] The published version of NR 205 contains a formatting error. The subparagraphs as noted in the text are shown at NR 205.07(1)(u) and the introduction to those paragraphs as noted in the text is shown at NR 205.07(2)(d).

With respect to any construction or normal maintenance that may result in an overflow of sewage from the permittee's sanitary sewerage system, any such overflow is prohibited unless authorized by DNR in writing. Any permittee seeking permission for a scheduled overflow due to construction or normal maintenance activities must provide information about the proposed date of the overflow, the estimated duration and volume of the overflow, the alternatives to allowing an overflow to occur, and measures proposed to mitigate any environmental harm caused by the overflow.

General Permit

Since 1989, sanitary sewer system owners that do not own or operate a sewage treatment facility are regulated by the terms and conditions of a general permit for discharges from these systems. On August 2, 1996 DNR reissued this general permit applicable on a statewide basis to bypasses and overflows of sewage from municipalities which own, operate, and maintain an individual sanitary sewerage system tributary to a neighboring downstream publicly-owned treatment works and which have not been issued a specific permit. This general permit expires on March 31, 2001 and reissuance efforts have already begun. Under the provisions of section 227.51(2), Wis. Stats., and section NR 205.08(9)(a), Wis. Adm. Code (which references section 227.14(2), Wis. Stats., subsequently renumbered to section 227.51(2)), the terms and conditions of the expiring general permit will continue in force and effect until the new general permit is issued.

The general permit states that no overflow of sanitary sewage from the permittee's sanitary sewerage system is authorized (part I.B.(1) on page 1) and provides monitoring, notification and corrective action requirements related to any overflows that occur (part I.B.(2) – (12) on pages 1 – 4). By March 31 annually, the permittee is required to submit to DNR a report for the previous year which summarizes the locations, dates, circumstances, and estimated volumes of sewage discharged for each overflow occurrence within the permittee's sanitary sewerage system (part I.B.(12) on page 4). The general permit contains provisions similar to specific permits regarding scheduled overflow (bypass) events.

Sewer Extension Eligibility Criteria - NR 110.05

Overflows of untreated sewage from municipal sanitary sewerage systems have been occurring throughout the State since the initial installation and operation of sewage conveyance systems. In 1971, the Department established a policy for denial of proposals for new sewer extensions if a community's existing sanitary sewer system was deemed inadequate to accept additional sewage flows (and/or if the sewage treatment facility was deemed to be overloaded). The new policy did not establish conditions or criteria under which the sanitary sewer system would be deemed inadequate, nor did it include provisions for requiring communities to report sewage overflows to the Department.

In 1974, the referenced policy regarding denial of requests for new sewer extensions was incorporated into the Wisconsin Administrative Code under s. NR 110.05. In effect, the code language stipulated that a community must consistently meet a minimum of secondary treatment standards for effluent discharges from sewage treatment facilities while simultaneously avoiding overflows in order to be eligible for approval of new sewer extensions. In subsequent rule revisions, a deadline of June 30, 1983 was established as the official target date for all communities to achieve compliance with these requirements in order to maintain eligibility for new sewer extensions. As part of rule revisions in 1981, definitions were incorporated to further distinguish between significant/frequent overflows (Category 1) and unusual/unavoidable overflows (Category 2).

Category 1 Overflows:

Category 1 overflows are defined under s. NR 110.05(2)(b), Wis. Adm. Code, as those that occur relatively frequently and under normal operating conditions and/or result from a fundamental deficiency of the sanitary sewer system and/or sewage treatment facility. This includes, for example, hydraulic capacity bottlenecks/constrictions, design code violations, excessive infiltration/inflow (I/I), etc. Category 1 overflows are considered very serious and will result in the permittee being ineligible for approval of sewer extensions (a sewer moratorium) unless appropriate corrective steps are taken.

Category 2 Overflows

Category 2 overflows refer to sewage discharges that occur infrequently and under abnormal operating conditions or circumstances such as random/unanticipated power, equipment, or structural failures or inadvertent operational problems or operator errors. Additionally, category 2 overflows may include those occurrences associated with a precipitation event that has an intensity corresponding to a 5-year or greater recurrence interval (i.e., a relatively significant and infrequent precipitation event). This may, for example, consist of an extreme event capable of surcharging the storm sewer system and causing ponding or flooding conditions. Other pre-existing localized conditions such as soil types, soil moisture conditions, recent storm patterns, etc., may also contribute to Category 2 overflows.

While Category 2 overflows continue to occur each year throughout the State, the number of Category 1 overflows have been significantly reduced. As of January 2001, there is only one community in the State currently under a sewer extension moratorium because of Category 1 overflows. Also, the Department continues to work directly with several communities in the State to further reduce the occurrences of Category 2 overflows.

Categorization Of Overflows

Based on the reports filed by the permittees as required by their WPDES permit, the Department reviews the incidents to determine the appropriate category of the overflow event. If the Department concludes after this review that the overflow occurrence was an isolated (infrequent) incident due to abnormal circumstances, then the occurrence is classified as Category 2. If the Department concludes after this review that the overflow occurrence is a Category 1 event, the permittee is no longer eligible to receive approval of sewer extensions until appropriate corrective steps are taken.

Before making a final determination on categorization, the Department will notify the permittee in writing of the potential for issuance of a sewer extension moratorium and request a meeting to discuss possible immediate and long-term measures/actions to reduce this potential. Assuming the permittee is willing to commit to a plan of action to address the underlying cause of the overflow problem, the Department will typically defer issuance of a Category 1 determination to allow a reasonable amount of time for implementing corrective measures. However, if the apparent trend of similar, frequent overflows continues unabated and the permittee has not demonstrated a willingness to seriously address the problem or cooperate with the Department, then a Category 1 determination (and a sewer extension moratorium) will be issued.

Department decisions regarding issuance of a sewer extension moratorium for Category 1 overflowing are generally very controversial due to the potential economic impacts on a community resulting from restrictions on growth. Also, Category 1 determinations for frequent overflows caused by excessive I/I have been contentious due to the significant

monetary costs and time factor generally required for implementation of the necessary improvements to eliminate the Category 1 overflows.[5]

It is also important to remember that s. NR 110.05(7), Wis. Adm. Code, specifically indicates that bypasses that result in a violation of the conditions of a WPDES permit may be subject to enforcement action regardless of the permittee's compliance status under s. NR 110.05(2), Wis. Adm. Code. Therefore, action or the absence of action under s. NR 110.05(2), Wis. Adm. Code, does not preclude enforcement under the terms of the permit.

Facilities Planning Requirements

Chapter 281, Wis. Stats., and Chapter NR 108, Wis. Adm. Code, require Departmental approval of all reviewable plans and specifications for sewerage systems. "Sewerage systems" include "all structures, including sewage treatment facilities, conduits, and pipelines by which sewage is collected and disposed of" (s. NR 108.02(14), Wis. Adm. Code). A reviewable project is defined to include "any new system or improvements, extensions or alterations of existing systems which may affect the quantity or quality of effluent or the location of any outfall" (s. NR 108.02(13), Wis. Adm. Code). The design standards for sewerage systems are contained in chapter NR 110, Wis. Adm. Code. For all reviewable projects, a "facilities plan" must be submitted to the Department and approved prior to submission of plans and specifications (s. NR 110.08, Wis. Adm. Code).

A facilities plan is an analysis of alternative methods for meeting a community's sewage collection, treatment and disposal needs. The purpose of the facilities plan is to:

1) Demonstrate the need for the proposed facilities (define "the problem"),

2) Demonstrate that the selected alternative is the most "cost-effective" alternative,

3) Provide the opportunity for the affected public to be adequately informed and involved in the selection of the recommended alternative, and

4) Ensure that the environmental, social and cultural considerations contained in the Wisconsin Environmental Policy Act are adequately considered in the selection of alternatives.

The requirements for the content of facilities plans are contained in ss. NR 110.09, NR 110.10, and NR 110.11, Wis. Adm. Code. To determine the size of treatment, storage and conveyance systems, it is necessary to define the design sewage flow rate. Sufficient capacity must be provided for sewage generated by residences, commercial buildings, industries, and institutions and "non-excessive infiltration and inflow."

Infiltration/Inflow and Sewer System Evaluation Surveys

Infiltration and inflow (I/I) are terms used to define groundwater and stormwater that finds it way into sanitary sewers by defects in pipes and joints, deterioration of the pipes and/or direct connections of stormwater sources to the sanitary sewer. "Infiltration" is defined in NR 110.03(16), Wis. Adm. Code, as water, other than sewage, that enters a sewer system from the ground through such sources as defective pipes, pipe joints, connections or manholes. "Inflow", on the other hand, is defined in NR 110.03(17), Wis. Adm. Code, as water, other than sewage, that enters the sanitary sewer system directly from sources

[5] The City of Superior has been under a "limited" sanitary sewer extension moratorium since 1992 due to Category 1 wet weather bypasses/overflows and has invested several millions of dollars on improvements to their sanitary sewer system and wastewater treatment facility during this period.

such as roof leaders, yard drains, foundation drains, manhole covers, or catch basins connected to sanitary sewers.

"Non-excessive" I/I is defined by a cost-effectiveness analysis. I/I is non-excessive when the cost of conveyance, storage and treatment is less than the cost of removing the I/I sources. The assumption in this analysis is that I/I is either conveyed and treated or is removed, entirely or in part, from the system.

Section NR 110.09(1)(b)3., Wis. Adm. Code, requires that a facilities plan for sewage treatment projects include I/I documentation. Section NR 110.09(5) and (6) detail two steps in the process of I/I evaluation. The first step in the I/I Analysis is an evaluation of costs of eliminating I/I versus the costs of conveyance, storage and treatment. If it is determined that the system is subject to "excessive" I/I, then a Sewer System Evaluation Survey (SSES) is required. The SSES identifies the specific defects in the sewer system that are cost-effective to remove.

The requirements for Facilities Planning, I/I Analysis and Sewer System Evaluation Surveys were originally developed for the federal Construction Grants Program to implement the Clean Water Act. These methods of analysis were incorporated into chapter NR 110 in 1974. In the 1970s and early 1980s, most communities were required to use the I/I Analysis and SSES process. Although substantial investments were made in sewer rehabilitation and repair, the results often did not meet expectations.

There are many reasons why these programs were less effective than expected. First, wet weather flow data available for the analyses in many communities was often insufficient or inaccurate. Secondly, the effectiveness of rehabilitation techniques was overestimated. In leaky sewer systems, some sources of I/I were masked by other sources so that while some defects were corrected, the I/I simply found other equally convenient paths of entry into the sewer. Thirdly, many communities found that correcting I/I sources on private property (often a significant source of I/I) was difficult and controversial. Grant money was available for work on public facilities, but not for private property rehabilitation.

Design Standards for Sizing Wastewater Facilities

The design requirements in chapter NR 110 do not specify the exact method by which the maximum (or peak) design flow is to be estimated. The chapter requires that sewage flow estimates include residential, commercial, industrial and institutional flows and "non-excessive" infiltration and inflow. The "performance standard" that is implied in the federal Clean Water Act is that overflows from the sewer system and bypasses at the treatment plant should not occur except under exceptional circumstances.

The design engineer develops an estimate of a "peak" flow condition in order to evaluate I/I removal or size sewerage facilities. Many different methods have been used to estimate the peak flow rate. The choice of method may be based partly on the availability and quality of data. For example, the largest measured flow over some past period might be used. If older data are believed to be inaccurate the largest measured flow in the last 3 or 5 years may be chosen as the peak flow.

If enough data is available to make a good correlation between flow and rainfall, then the peak flow may be extrapolated to a "design storm" condition. For example, if the largest measured flow occurred during a 1.5 inch rainfall, then the engineer may estimate, based on available data, what flow would be expected during a larger rainfall event that may equate to a 10-year frequency storm. In some instances, detailed modeling analyses may be conducted to produce a correlation between rainfall events and sewage system flows

A large margin for error exists in these analyses because of our inability to accurately account for all the variables involved. Even when sufficient data is available to allow a sophisticated analysis of infiltration and inflow, two storm events with the same measured rainfall can produce vastly different amounts of I/I depending on preceding rainfall, snow cover, frost depth and intensity and extent of the rainfall. Sewers and treatment facilities can be designed conservatively. However, there are limits to how large facilities can be built and still function effectively during average conditions. Furthermore, none of these methods can accurately depict how changes in the integrity of the sewer system, over time, will affect the amount of I/I that enters the system.

Federal Regulatory Requirements

Combined Sewer Overflows

In 1994, after several years of development, EPA published the Combined Sewer Overflow Control Policy. This policy was designed to provide greater national clarity and consistency in the way permit requirements apply to combined sewer systems and is best characterized by the following nine minimum controls that are expected for CSO systems:

1) Proper operation and regular maintenance programs for the sewer system and the CSOs;

2) Maximum use of the collection system for storage;

3) Review and modification of pretreatment requirements to assure CSO impacts are minimized;

4) Maximization of flow to the treatment plant;

5) Prohibition of CSOs during dry weather;

6) Control of solid and floatable materials in CSOs;

7) Implementation of pollution prevention activities;

8) Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts; and

9) Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls.

In addition, the policy required all CSO communities to develop a Long Term Control Plan. Long-term CSO control plans are intended to evaluate alternatives for attaining compliance with the CWA, including compliance with water quality standards and protection of designated uses. Once the long-term CSO control plans are completed they are to be implemented “as soon as practicable.”

EPA s guidance on preparation of Long Term Control Plans (available on the internet at http://www.epa.gov/owm/csopol.htm) indicates one of the following two approaches to CSO control should be adopted:

1) The “presumptive approach” is a program that meets any of the criteria listed below and is presumed to provide an adequate level of control to meet the water quality-based requirements of the CWA:

- No more than an average of four overflow events per year, provided that the permitting authority may allow up to two additional overflow events per year. For the purpose of this criterion, an overflow event is one or more overflows from a CSS as the result of a precipitation event that does not receive the minimum treatment specified below; or

- The elimination or the capture for treatment of no less than 85% by volume of the combined sewage collected in the CSS during precipitation events on a system-wide annual average basis; or

- The elimination or removal of no less than the mass of the pollutants, identified as causing water quality impairment through the sewer system characterization, monitoring, and modeling effort, for the volumes that would be eliminated or captured for treatment under the immediately preceding paragraph.

2) The "demonstration approach" allows a permittee to demonstrate that a selected control program is adequate to meet the water quality-based requirements of the CWA including attainment of water quality standards.

The selected long-term control strategy should include a post-construction water quality monitoring program to verify compliance with water quality standards and protection of designated uses as well as to ascertain the effectiveness of CSO controls

Sanitary Sewer Overflows

U.S. EPA regulations contain prohibitions on "bypasses" and overflows that are similar in some respects to those contained in ch. NR 205. However, the requirements are not, in application, precisely the same. U.S. EPA has established the "wet weather" issue as a national enforcement priority. EPA, Region 5 has also identified control of SSO and CSO as a priority activity. Based on concerns from the public, EPA has identified the frequency and magnitude of SSO and CSO in the Milwaukee metropolitan area as a cause for concern and a topic that requires further evaluation to determine if the applicable discharge permit requirements are being met and what follow-up actions may be needed.

Proposed SSO Rule

EPA, under the authority of the Federal Advisory Committee Act, established an advisory group in 1995 to address the issue of urban wet weather flows. In response to concerns of the regulated community, EPA created a subcommittee of the larger committee to specifically address sanitary sewer overflows. After several years of deliberation, this Advisory Subcommittee came forth in October 1999 with 4 primary recommendations for EPA's SSO policy. They were:

1) A reaffirmation of the prohibition on SSO, including a framework for raising an "affirmative defense" for unavoidable discharges, including those resulting from "widespread flooding";

2) A requirement that all municipal sewer systems operate a "capacity, management, operation and maintenance" program for the collection system;

3) A requirement that all collection systems tributary to a treatment plant owned by a different governmental unit be subject to the terms and conditions of a federal or state discharge permit; and

4) A recommendation that EPA create a policy for dealing with remote treatment facilities for peak excess flow.

During the past year, following EPA creation of a draft regulation package, the federal Office of Management and Budget has evaluated and commented on the changes that EPA proposed. Late in year 2000, the EPA administrator signed a regulatory package containing proposed revisions to EPA regulations regarding SSOs. The elements of these draft regulations are similar to those forwarded by the federal advisory subcommittee, namely:

1) A prohibition on SSOs, with opportunity for a defense based on severe weather conditions and lack of feasible alternatives;

2) Creation of a mandatory "capacity, management, operation and maintenance" program;

3) Establishment of a reporting system; and

4) Requiring permits for satellite collection systems that are tributary to regional treatment facilities.

U.S. EPA Region 5 has acknowledged that Wisconsin's program for addressing SSOs includes a number of important elements, such as permitting of satellite (tributary) communities, and reporting, which are consistent with EPA's draft proposed SSO rules. The rule proposal is currently under review by the new EPA administration.

Inplant diversions

While inplant diversions or bypasses of some sewage flow around various components of a treatment works is a common design feature at sewage treatment facilities, there are no federal regulations dealing with specifically with inplant diversions. U.S. EPA is currently considering the question of whether, or under what conditions, such inplant diversions are subject to the bypass prohibition at 40 CFR 122.41(m). In most instances today, these diverted flows recombine with the fully treated sewage stream prior to monitoring at the outfall. Many plants in Wisconsin have been approved by the Department with this inplant diversion feature.

Under state rules, inplant diversions of the type described are, by definition, regulated under the "unscheduled bypassing" provisions in chapter NR 205, Wis. Adm. Code. The prohibition (with noted exceptions) applies in spite of Department approvals of such designs. As long as effluent limits are attained, the Department has not taken enforcement action for this type of diversion.

The state rules on inplant diversions are patterned after applicable federal regulations. However, there is a substantial debate currently underway within EPA as to whether inplant diversions should or should not be allowed. As in Wisconsin, the EPA construction grants program allowed, and funded, such elements of sewage treatment plants. While there is debate within EPA regarding this issue, EPA, Region 5, has verbally indicated that as long as effluent limits are attained, and provided these diversions are necessary to protect plant components and operations, such inplant diversions should not be considered an enforceable incident.

Other States

There are only three combined sewer systems remaining in Wisconsin through the joint efforts of Wisconsin communities, the DNR and predecessor agencies. By comparison, within the states comprising EPA's Region 5, Illinois, Indiana and Ohio each have about 100 CSO communities and Michigan has about 60. Minnesota, like Wisconsin has three. As noted earlier, about 950 cities nationwide have combined systems. Many states and municipalities have not actively pursued full implementation of CSO control programs following the 1994 EPA policy. Within the past couple of years, EPA has successfully taken enforcement action against some large cities for failure to implement CSO control programs. Atlanta and Indianapolis are examples of such cities.

With respect to SSOs, EPA estimates there are over 40,000 such events in communities across the country each year. Surveys by various organizations indicate that SSOs are experienced in one-half to two-thirds of the systems surveyed. Most states do not exercise regulatory authority over collection systems that do not have treatment facilities. With the addition of such systems, it is likely that the percent of communities that have SSOs is even larger.

Milwaukee Area

History through 1981

In 1868, 22 years after the City of Milwaukee was chartered, the Milwaukee City Council authorized an engineer to draw up preliminary plans for water and sewerage systems for Milwaukee. However, the city's early sewer system did not include any sewage treatment. When water quality in local rivers and near shore Lake Michigan worsened during the late1800s and early1900s, politicians debated possible solutions. As a result, the Sewerage Commission of the City of Milwaukee was established by the Wisconsin Legislature in 1913 and the Commission was assigned the task of designing and building a complete sewage treatment system.

The Commission experimented in 1914 with a new approach for secondary treatment of sewage known as the activated sludge method, a biological process that utilizes microorganisms to break down pollutants. In early 1916, a testing plant was put into operation to treat Milwaukee's sewage. By 1925, the first part of the Jones Island Wastewater Treatment Plant was opened, becoming the largest facility in the nation to put the activated sludge process to use.

Other Milestones in the history of Metropolitan Sewerage District:

1921 -- The Metropolitan Sewerage Commission of the County of Milwaukee is created.
1933 -- A report recommends the ultimate service area as presently established and another treatment plant to be built in Oak Creek around 1960.
1939 -- The site for South Shore wastewater treatment plant is purchased.
1960 -- The Sewerage District expands to all of Milwaukee County, except City of South Milwaukee; construction begins on South Shore treatment plant.
1974 -- The first Wisconsin Pollutant Discharge Elimination System Permits (WPDES) issued by Department of Natural Resources governing Sewerage District facilities.
1977 -- The Water Pollution Abatement Program (WPAP) established to begin repairs and expansion of the entire metropolitan area sewage conveyance and treatment system.

1981 -- The U. S. Environmental Protection Agency and the Wisconsin Department of Natural Resources approve MMSD's Master Facility Plan

Description of the Milwaukee Metropolitan Sewerage System

The Milwaukee Metropolitan Sewerage District is a state chartered, government agency providing wastewater services for 28 municipalities and nearly 1.2 million people. While Milwaukee is the 17th largest city in the United States, its regional wastewater system is the seventh largest and among the most sophisticated and well-run in the country. The District's 420-square-mile service area includes all cities and villages, (except the City of South Milwaukee), within Milwaukee County and all or part of 10 municipalities in the surrounding counties of Ozaukee, Washington, Waukesha and Racine.

Sewage is conveyed to the Jones Island and South Shore wastewater treatment plants by a 2,200-mile system of collector sewers and a 310-mile system of intercepting and main sewers. The two treatment facilities collect and treat more than 200 million gallons of sewage each day, during dry weather conditions. During major storm events, tributary flows can exceed 1 billion gallons per day.

In late 1993, the District completed construction of the Inline Storage System (deep tunnel). The system enables the District to collect, store and convey the increased sewage volumes associated with storm events to either or both treatment plants.

Jones Island wastewater treatment plant

Located along Lake Michigan on a peninsula in Milwaukee's harbor, the Jones Island wastewater treatment plant has been in operation for more than 70 years. Originally designed to treat 85 million gallons of raw sewage per day, recent expansion and renovation as part of the District's $2.3 billion Water Pollution Abatement Program increased the plant's capacity to 150 million gallons on a typical day and peak capacity of 330 million gallons per day. Average flows to the plant currently are about 112 million gallons per day.

Nearly all solids from the treatment process are dried and made into Milorganite, a commercial fertilizer sold throughout the United States and Canada. The 5 percent of solids that are not recycled are hauled to a sanitary landfill.

Because of its historic leadership in sewage treatment, the Jones Island facility has been designated a National Historic Civil Engineering Landmark by the American Society of Civil Engineers and is the only sewage treatment plant in the United States receiving such distinction from the society. The site has also been placed on the National Register of Historic Places.

The effluent limitations on the discharge from the Jones Island treatment plant are as follows:

Biochemical Oxygen Demand (BOD)	45 mg/L – weekly average	30 mg/L – monthly average
Total Suspended Solids	45 mg/L – weekly average	30 mg/L – monthly average
Chlorine Residual	35 ug/L – weekly average	37 ug/L – Daily Max.
Fecal Coliform		400 colonies/100 ml – monthly average
Phosphorus		1.0 mg/L – monthly average
PH	6.0 – daily minimum	9.0 daily maximum

South Shore wastewater treatment plant

Located to the south of the Jones Island facility along the Lake Michigan shoreline in Oak Creek, the South Shore wastewater treatment plant was put into operation in 1968. It treats an average of 100 million gallons of sewage each day, most of it from the southern and western portions of the District's service area. The facility has a peak treatment capacity of 300 million gallons per day.

Sewage at the South Shore plant flows by gravity through primary, secondary and tertiary treatment processes identical to those at the Jones Island plant. However, instead of producing Milorganite fertilizer as at Jones Island, biosolids are sent to anaerobic digesters where microorganisms convert a large part of the biosolids into methane gas. This gas is collected and burned to produce electricity for the plant.

The treated effluent water is discharged to Lake Michigan through a pipeline diffuser located about 2500 feet offshore, while the remaining biosolids are applied to farmland as a liquid fertilizer and soil conditioner known as Agri-Life.

The effluent limitations on the discharge from the South Shore treatment plant are as follows:

Biochemical Oxygen Demand (BOD)	45 mg/L – weekly average	30 mg/L – monthly average
Total Suspended Solids	45 mg/L – weekly average	30 mg/L – monthly average
Chlorine Residual		37 ug/L – Daily Max.
Fecal Coliform		400 colonies/100 ml – monthly average
Phosphorus		1.0 mg/L – monthly average
PH	6.0 – daily minimum	9.0 daily maximum

In addition, there is an limitation on ammonia that is effective from June through September of each year, is based on pH and ranges from 6.7 mg/L to 16.7 mg/L.

The Treatment Process

The treatment processes at both Jones Island and South Shore are comparable. Preliminary treatment is the first step in processing sewage entering the plant. In preliminary treatment, large and untreatable material like wood, rags, sand and grit are removed from the sewage. In the next step, called primary treatment, heavier solids settle to the bottom of large circular tanks called clarifiers, while lighter solids float to the surface.

After the solids have been removed, the water flows to the secondary or biological activated sludge process. In the activated sludge process, large amounts of air are pumped into the sewage so that bacteria and other microorganisms can consume soluble oxygen-demanding pollutants in the sewage. Tertiary treatment or removal of phosphorus is also accomplished in the activated sludge process. It is important to remove phosphorus since discharging it into Lake Michigan could degrade the water by stimulating algae growth. To accomplish phosphorus removal, a small amount of iron sulfate or "pickle liquor," (a waste product of manufacturing), is added to the sewage, causing the phosphorus to precipitate and allowing it to be removed as a solid.

After aeration, the sewage, which now contains "activated" sludge, flows into huge settling tanks known as secondary clarifiers. Here the sludge, or biosolids, settles to the bottom

and treated water remains at the top. It is at this point that the treatment process becomes divided into two streams" - liquid and solids.

The treated water flows from the clarifiers into contact basins where chlorine is added to kill harmful bacteria. But before the treated water is discharged to Lake Michigan, any remaining chlorine is removed by adding a neutralizing chemical. This is done to ensure that no fish toxicity is caused when the water is discharged to Lake Michigan.

In the solids stream, most of the settled activated sludge is returned to the aeration tanks where it continues the treatment process by "seeding" or "activating" the primary effluent. To balance the process, a small portion of the activated sludge biosolids must be continuously removed. These biosolids are filtered and dried to produce Milorganite fertilizer and Agri-life.

In-plant Diversions

During periods of wet weather the treatment plants are operated to treat the maximum amount of sewage possible. A method employed at the Jones Island treatment plant is called an inplant diversion. This process is used during wet weather periods, not during normal dry weather conditions. Under these extreme events, the plant has the capability to divert sewage around the secondary treatment tanks to prevent washout of the biological solids in the tanks. Under these circumstances, the plant provides disinfection to all the sewage, as well as primary and secondary treatment for a large portion of the flow. This standard procedure is used during periods of heavy rains to maximize water quality benefits and was incorporated in the design of the sewage treatment plant.

Diversions are necessary to protect the biological secondary treatment process which, even during a diversion, continues to treat the majority of flow. Without a diversion, under high flow conditions, two results are possible. First, a significant percentage of the mass of microorganisms in the secondary treatment tanks may be washed out and plant performance will deteriorate. This will result in three to four days of poor effluent quality for the entire plant while the microorganisms regain viability as opposed to several hours of lower quality effluent, though still meeting permit requirements during the diversion. Alternatively, the flows being diverted would otherwise be bypassed to the rivers without any treatment. Compliance with effluent limitations is determined by collecting effluent samples that are representative of the actual discharge after the main plant flow and the diverted portion are recombined.

Inline Storage System (ISS)[6]

The ISS has the following general characteristics:

1) In operation since 1994

2) 400 million gallons storage capacity

3) Tunnels are 300 feet below ground

4) Tunnels more than 20 miles long

5) Tunnels range from 17 to 32 feet in diameter

[6] The ISS is also known as the “deep tunnel system:. For purposes of this document, we will use ISS to refer to this system.

6) 24 dropshafts allow CSO and SSO to flow into the tunnels

7) Three dewatering pumps each with a fifty million gallons per day capacity

The system's function is to provide a mechanism for conveying and/or storing excessive wet weather flows to reduce the frequency and volume of SSO and CSO that was historically discharged to area surface waters. Since 1994, the ISS has kept more than 37 million gallons of untreated CSO and SSO from entering Lake Michigan and area waterways. Prior to the ISS's operation, there were 40 to 60 CSO events per year. Between 1994 and 2000 there has been an average of 2.5 CSO events per year. The ISS has also drastically reduced the frequency and volume and altered the location of SSOs.

Several cities with sewer systems similar to Milwaukee's have experienced the following annual average number of CSO events: Boston, MA. (70), Indianapolis, IN. (30), Pittsburgh, PA. (45), Portland, OR. (100), and St. Louis MO. (106). Many of these communities are now beginning efforts to address their CSO problem.

Operation of the ISS is crucial to minimizing the number and volume of SSOs and CSOs The District continues to gain operational experience with the ISS and continues to collect empirical performance data to move toward optimum use of the system. As part of this process, WPDES permit conditions dictate certain operational parameters that must be followed:

1) Separate sewer overflows are to be eliminated; priority is placed on capture of separate sewer flows;

2) ISS fill level must not exceed an amount that results in significant exfiltration into the surrounding bedrock;

3) Consistent with the Long Term Control Plan component of U.S. EPA's 1994 CSO policy, combined sewer overflows are allowed up to six times per year without specific volume restrictions.[7]

During a rainfall event over a large area of the District, due to proximity of the combined sewers to the ISS, flow from the combined system usually reaches the tunnels first. Given the travel time for sewage in the sanitary and interceptor sewers upstream of the ISS, sewage from the separated area usually reaches the ISS dropshafts after CSO is already flowing into the ISS. When the ISS initially began operating, the protocol was to fill the tunnels to 80% capacity with combined sewage. At this point, the gates from the combined sewers were closed and flow from the separated sewer areas only could enter the ISS. Sewage from the combined sewer system overflowed to surface waters at this time. Sewage from the separated area then flowed to the ISS until the system was full or the flow subsided. If the ISS is filled to capacity, all gates at the dropshafts will close and SSO will then begin discharging from the Metropolitan Interceptor Sewers.

Over time, MMSD's protocol for the system has changed based primarily on the premise that capture of sewage from the separated area is a higher priority. Therefore, at the present time, the ISS is filled to 50% capacity from the combined sewer area, with the remaining 50% reserved for the flows that eventually arrive from the separated areas. The system operators can change this operating protocol depending on the rainfall data that is collected during each event. Under the current operating protocol, it is possible, should

[7] The final number of overflows allowed that will meet water quality standards will be determined based upon an evaluation of the water quality impacts of CSO and other sources of water quality impairment. Additional information on water quality studies are contained in Sections IX.F. and IX.G. on pages 35 and 36 of this report.

sufficient flow from the separated areas not materialize, that the ISS will not fill to full capacity.

One of the uncertainties associated with system operation is the variability in rainfall across the area tributary to the ISS. As MMSD gains experience, collects additional data on rainfall and flow in the sewerage system and installs improved real-time monitoring systems, changes in ISS operation should allow further system optimization to assure full use of the system during each event. All sewage collected in the ISS tunnels is pumped to the surface and is treated at the Jones Island and South Shore facilities. Under extreme events, there may be in-plant diversions at these facilities as described earlier.

The ISS tunnels are located approximately 300 feet below the ground surface in the dolomite bedrock. At this depth, the tunnels are below the water table. While much of the system is lined with concrete, portions were left unlined based on the bedrock characteristics at those areas . When the tunnels are empty, groundwater enters the tunnel through cracks in the bedrock, through joints and other places. Currently, this rate is approximately six to eight million gallons per day. During dry weather periods, approximately 30 million gallons is allowed to accumulate in the tunnels before this is pumped to the plants for treatment. This amount of water is needed before the pumps can begin to effectively remove groundwater from the ISS. When a rainfall event is anticipated, standard operating practice of the MMSD is to begin pumping out the ISS tunnels.

The Dane County Stipulation and Other Legal Requirements

Overview

The Dane County Stipulation was the basis for a May 25, 1977 judgment of the Dane County Circuit Court in the matter of The Sewerage Commission of the City of Milwaukee and the Metropolitan Sewerage Commission of the County of Milwaukee v. the State of Wisconsin Department of Natural Resources, case no. 152 – 342. The Stipulation agreed to by the parties was incorporated into the judgment by reference, and its terms were adopted as the judgment of the court.

The DNR had issued sewage discharge permits for the Jones Island and South Shore treatment plants to the Sewerage Commission of the City of Milwaukee (the “City Commission”). Those permits required that by December 27, 1974 the Jones Island treatment plant meet secondary and applicable water quality treatment standards and by January 1, 1975 the South Shore treatment plant meet the same standards.

On July 7, 1976 the City Commission sought judgment declaring that the portion of section NR 210.10, Wis. Adm. Code, which authorized DNR to require secondary treatment standards to be met by publicly owned treatment works before July 1, 1977 was in excess of the agency’s jurisdiction. The City Commission also sought judgment declaring that those portions of the Jones Island and South Shore permits requiring secondary treatment prior to July 1, 1977 were void.

The DNR filed an answer and counterclaim and alleged the following:

1) The federal government, by the Federal Water Pollution Control Act Amendments of 1972, was authorized to require publicly owned treatment works to meet secondary treatment standards on or before July 1, 1977;

2) DNR was authorized by section 147.04(3)(a), Wis. Stats. (now section 283.13(4)(a)), and section NR 210.10, Wis. Adm. Code, to require publicly owned treatment works to achieve secondary treatment standards on or before July 1, 1977;

3) Since January 1, 1975 the City Commission had violated the effluent limitations in its Jones Island and South Shore permits a total of more than sixty times;

4) Sewage generated within the service area of the City Commission and the Metropolitan Sewerage Commission of the County of Milwaukee (the "County Commission") contributed to the overloading of the Jones Island and South Shore plants and exacerbated the inadequate sewage treatment being provided by those plants;

5) Under dry weather and wet weather conditions, bypassing and overflowing occurred within the sewerage systems of the commissions and such discharges must either be eliminated or meet secondary treatment standards by July 1, 1977; and

6) Violations of treatment standards at Jones Island and South Shore, and bypass or overflow discharges within the sewerage systems, would continue to occur until such time as sewerage system improvement projects were completed.

The DNR demanded judgment for, among other things, a mandatory injunction requiring the City Commission to take steps to bring it into compliance with the terms of its Jones Island and South Shore permits.

While the City Commission was the permittee, the County Commission was charged by law with the duty of projecting, planning, constructing and establishing a sewerage system for the collection and transportation of sanitary and industrial sewage from areas outside of the City of Milwaukee. However, within the service area of the Metropolitan Sewerage District of the County of Milwaukee (the "District", now known as "MMSD") for disposal at the Jones Island and South Shore sewage treatment plants, all subject to approval by the City Commission. MMSD was a corporate body acting through the agency of the commissions and under law held title to all property obtained by either or both commissions.

The Stipulation was agreed to by the parties to settle the above referenced action by establishing a program of pollution abatement projects to be carried out in the District. Completion of those projects would enable MMSD to upgrade its system to meet applicable Clean Water Act and state requirements. The Stipulation required MMSD to conduct a sewer system evaluation survey (SSES) throughout the entire District and submit to DNR a report for each participating municipality by July 1, 1980 (see section B.2. – 4. on page 8).

The Stipulation also delineated a number of sewage treatment plant and sewage system improvements to be completed by deadlines set forth in the Stipulation. Recognizing the need for the continued availability of federal financial assistance and state funding of eligible project costs, the Stipulation established minimum annual expenditure levels for the years 1977 through 1993 (see section A.1.(b) on page 4) and beyond (see section C.3. on page 10). The Stipulation also provided local funding priorities, minimum expenditures and a timetable in the event such federal or state financial assistance is not available (see section A.2. on page 5).

Effluent limitations

The Stipulation required that all discharges from the sewerage systems and treatment plants owned and operated, either individually or collectively, by the commissions be eliminated by July 1, 1977 or meet secondary and applicable water quality related treatment standards by that date (see section F.3. on page 14).

Sanitary sewer overflow (SSO) requirements

With respect to sanitary sewer overflows, the Stipulation required the elimination of any bypassing or overflowing which occurs within the sewerage systems under dry weather conditions by July 1, 1982 (see section A.1.(c)(5) on page 4 and section A.2.(a)(2)(e) on page 6). The Stipulation required the commissions to assure that each participating municipality completes the correction of wet weather bypassing and overflowing within its separate sewer areas by July 1, 1986, regardless of the availability of federal or state financial assistance for those projects (see section B.5. – 7. on page 9). To meet that deadline, the Stipulation required the commissions to adopt rules and regulations requiring each municipal customer of the District to agree to an acceptable program, time schedule and financial commitment for correction of its wet weather overflows or bypasses occurring from separate sanitary sewers (see section D.6. on page 12).

Combined sewer overflow (CSO) requirements

With respect to combined sewer overflows, the Stipulation required the Commissions to correct any bypassing or overflowing which occurs within the combined sewer areas of the City of Milwaukee and the Village of Shorewood by following a schedule delineated in section C.2. on page 10. That schedule requires that the CSO abatement project include completion of construction and achievement of applicable water quality standards by July 1, 1993. However, a final determination in this regard cannot be made until additional work, as described in Section IX.G. of this report, is completed.

Current permit conditions and compliance with the stipulation

The ISS was completed in 1993. MMSD's current sewage discharge permit, issued on June 29, 1997 and in effect until March 31, 2002, prohibits SSO by stating:

> *"No bypass or overflow of wastewater from the permittee's sanitary sewage system is authorized by this permit, and the Department may initiate legal action regarding such occurrences as authorized by s. 283.89, Wis. Stats."* (see part H.(3) on page 11).

In addition to the above prohibition on SSO, there is a provision in the "Standard Requirements" part of the permit that prohibits bypassing except in very limited circumstances. Part Q.(17) on pages 51 and 52 of the permit states in part:

> *"Any unscheduled diversion or bypass of wastewater at the treatment work or collection*
> *system is prohibited except in the following cases: (a) an inadvertent bypass resulting from equipment damage or temporary power interruption; (b) an unavoidable bypass necessary to prevent loss of life or severe property damage; or (c) a bypass of excessive storm drainage or runoff which would damage any facilities necessary to compliance with the effluent limitations and prohibitions of the permit…."*

The permit does recognize the occasional need for scheduled bypassing due to construction or maintenance reasons. Any request by the permittee for scheduled

bypassing must specify the proposed date of the bypass, the estimated duration of the bypass, any alternatives to bypassing, and measures that will be taken to mitigate any environmental harm caused by the bypass (part Q.(18) on page 52).

MMSD's current permit also establishes performance standards with respect to CSO. Part J on pages 33 – 36 of the existing permit provides in part:

1) No discharge shall occur during dry weather periods (part J(1)(a)).

2) No discharge shall occur during wet weather periods except when the gate at the dropshaft downstream must be closed to prevent the ISS separated sewer or combined sewer capacity from being exceeded (part J.(1)(b) 1)), or the capacity of the associated near-surface collector is exceeded (part J.(1)(b) 2)).

3) The ISS shall be operated and maintained in a manner to achieve, in any given year, either one of the following two performance standards:

   - No more than six overflow discharge events per year under design conditions. Design conditions are the storm of record conditions as precipitation patterns for the period from 1940 through July, 1979. For purposes of this paragraph, an overflow event is one or more discharges through the MMSD's CSOs as the result of a precipitation event (part J.(1)(d) 1)); OR
   - The capture and delivery to either the Jones Island or South Shore wastewater sewage treatment plants of no less than 85% by volume of the combined sewage collected in the Combined Sewer System (CSS) as the result of precipitation events on a system-wide annual average basis. The volume of the combined sewage collected in the CSS as the result of precipitation events on a system-wide annual average basis shall be the sum of: volume of flow discharged at Jones Island + volume of flow dishcarged at South Shore + volume of flow discharged through CSOs – volume of average daily base flow… (part J.(1)(d) 2))

General permit applicability

As described earlier on page 11, municipalities which own, operate, and maintain an individual sanitary sewerage system that is tributary to a neighboring downstream publicly-owned treatment works and which have not been issued a specific permit are regulated by the terms and conditions of a general permit. The 28 communities that are tributary to the MMSD system are covered by such permits. The general permit states that no bypass or overflow of sanitary sewage from the permittee's sanitary sewerage system is authorized and provides monitoring, notification and corrective action requirements related to any bypasses and overflows that occur.

Description of the Milw. Water Pollution Abatement Program

MMSD's Water Pollution Abatement Program (WPAP) is the largest public works project in the State to date. In 1980, MMSD developed the Master Facilities Plan (MFP) which delineated the projects to be included in the WPAP. The MFP covered the period 1985 to 2005. The major elements of the $2.3 billion WPAP included:

1) Modernization and expansion of the Jones Island Wastewater Treatment Plant to a peak capacity of 330 million gallons per day (MGD).

2) Expansion of the South Shore Wastewater Treatment Plant to a peak capacity of 250 MGD.

3) Construction of the Inline Storage System.

4) Construction of new interceptor and relief sewers and sewer rehabilitation projects.

The Inline Storage System consists of 17 miles of tunnels varying in diameter from 17 to 32 feet constructed at a depth of 275 to 325 feet. The system has the capacity to store 400 million gallons of wastewater that would previously have been discharged to Milwaukee's waterways.

Improvements at the Jones Island plant included the expansion of the Milorganite production to 200 dry tons per day. Milorganite is a dry fertilizer product produced from wastewater solids known as sludge. To facilitate the production of Milorganite, a 12 mile interplant solids pipeline was constructed which allows transfer of sludge between the South Shore and Jones Island plants. The WPAP was completed in 1996.

The WPAP was based on an I/I Analysis (I/I) and a Sewer System Evaluation Survey (SSES) conducted by MMSD. The I/I Analysis determined that excessive I/I was entering the MMSD interceptors and local community sewers and recommended that an SSES be conducted. The SSES was a detailed evaluation of the entire sanitary sewer system tributary to MMSD. This included about 2800 miles of sewer and 80,500 manholes in a service area of 420 square miles. The SSES study cost about $23 million in 1980 dollars. Approximately 2100 miles of sanitary sewer and 50,000 manholes were inspected. In addition, extensive flow monitoring was conducted.

The SSES identified over 400 active bypass and overflow locations in the local separated sewer systems and about 20 sanitary sewer overflow locations in the MMSD interceptor system. At that time, some of the local municipalities had not identified all of the overflows in their communities because of poor records. In addition, there was insufficient flow data to document the frequency and volume of the overflows.

Based on the analysis of available information, the SSES recommended sewer rehabilitation and construction of relief sewers. About $32 million was expended on rehabilitation of the MMSD interceptors and local sewers. An additional $18.5 million was recommended for local relief sewers and $84.3 million was needed for increased capacity in the MMSD interceptors. The Inline Storage System for storing excess flows cost $705 million. During the I/I and SSES studies, MMSD determined that the flow monitoring data available during the I/I and SSES studies was inadequate and upgraded the flow monitoring system at a cost of about $13 million.

The design basis used to determine how much storage capacity would be needed to prevent SSOs was an event that occurred in June 1940. This “design storm” assumed uniform distribution of a rainfall event with the following characterization: total precipitation (ppt.) after 1 hour = 1.2 inches, total ppt. after 6 hours = 3.2in., total ppt. after 12 hours = 3.9 in., total ppt. after 24 hours = 4.7 in., and total ppt. after 36 hours = 5.3 in. Mathematical modeling of the MMSD system being exposed to such an event predicted that 400 million gallons of storage would be needed to prevent overflows. Mathematical modeling of the response of the combined sewer service area to a series of rainfall events also predicted that 400 million gallons of storage would be able to capture the CSO from all but two events during a year of typical rainfall patterns.

The WPAP succeeded in increasing the capacity and improving the efficiency of wastewater treatment at Jones Island and South Shore, improved sludge handling systems and increased Milorganite production, greatly reduced both SSOs and CSOs and resulted in noticeable improvements in water quality.

The objectives of the ISS were to eliminate SSO up to what is termed the "design storm" and to correct CSO. Prior to the completion of the ISS , the number of CSO events were as follows: 66 CSO events in 1991, 46 CSO events in 1992, and 64 CSO events in 1993. Following completion of the ISS, there was only one CSO event each year in 1994, 1995 and 1996. In 1997 and 1998 there were only two CSO events each year. In 1999 and 2000 there were 6 and 5 CSO events, respectively, one of which resulted from a rainfall event that exceeded the storm of record over 75% of the MMSD service area. Data surrounding these events will help MMSD plan, design and implement system enhancements to achieve full compliance with the requirements for SSO and CSO in the 1977 Dane County Stipulation.

2010 facilities plan

After completion of the Water Pollution Abatement Program, significant quantities of I/I continued to be tributary to MMSD's system and questions were raised about the capacity of the system. In 1992, DNR modified MMSD's discharge permit to require the District to conduct a study of the capacity of its conveyance, storage and treatment facilities through the year 2005 and to identify any needed facility improvements. The District contested the permit modification. The Administrative Law Judge's ruling in the contested case hearing vacated DNR's modification and instead modified MMSD's permit to require that a facilities plan be prepared that would evaluate the District's facility needs through the year 2010. MMSD petitioned for circuit court review of that decision. The circuit court affirmed the Administrative Law Judge's decision and established the schedule for submitting the facilities plan. The 2010 facilities plan was submitted to DNR in August 1997 and approved in December 1998.

By reducing I/I, increasing system capacity and improving operational efficiency, the projects outlined in the 2010 facilities plan will help reduce the frequency and volume of SSO discharged in MMSD's service area. MMSD has planned for the construction of system enhancements in the amount of $919 million that are designed to reduce the potential for separated and combined sewer overflows. These enhancements (some of which are completed and some that are under construction) include the 25 relief sewer projects, treatment plant modifications, control and information system modifications and other improvements which are recommended under the 2010 Facilities Plan ($350 million); completion of the Flood Management Program (to keep floodwaters from entering sanitary sewers thus reducing I/I; $250 million); completion of programs to reduce I/I ($17 million); and an overhaul of the central Metropolitan Interceptor System (MIS; $350 million). These expenditures are planned over the next six to eight years. In addition to these projects, MMSD used its rule-making authority to adopt new requirements for tributary communities to reduce I/I by 5%.

The 1980 MFP and the 2010 Facilities Plan used similar methods to evaluate the conveyance and storage needs of MMSD's system. In both plans, separate analyses were conducted for storage needs and for MIS conveyance needs. The 1980 MFP design condition for conveyance was the event that yielded the highest flows recorded at the South Shore treatment plant prior to 1979. This design condition was chosen because flows at South Shore are a better indicator of peak separated area flows, whereas the flows at Jones Island include the combined sewer area. The 1980 MFP design conveyance storm occurred on May 12-13, 1978. This May 1978 event was caused by 3.11 inches of rainfall in a 24-hr period and was fairly uniform over the service area. The storm occurred during an extended wet weather period and it was assumed that soils were saturated prior to the event. The 5-year, 24-hour storm for Milwaukee is 3.33 inches. The 5-year, 12-hour storm is 2.90 inches. At 12 hours, the May 12-13, 1978 storm yielded

3.01 inches. The design condition, based on that 1978 storm, therefore, approximates a 5-year recurrence interval storm.[8]

The design condition in the 2010 Plan for conveyance was selected in the same manner. The storm event that produced the highest recorded flows at South Shore, updated for the period 1979 to 1995, occurred on May 9 –10. 1990. The total precipitation over 36 hours was 3.39 inches with 2.87 inches accumulated in the most intense 24-hour period. This storm, similar to the 1978 storm, occurred in a wet weather period and was fairly uniform over the service area.

The storage analysis in the 1980 MFP used a complex mathematical model to analyze rainfall data from period 1940 to 1979. The maximum storage requirement was generated by the June 21-22, 1940 rainfall event.

The 2010 Plan updated the storage analysis model used in the 1980 MFP and further evaluated events from 1979 through 1995. The 2010 plan evaluated both a Zero Overflow Control Objective (equivalent to the 1980 MFP design condition) and a 5-year Frequency Overflow Objective. The 2010 plan estimated that an additional 420 acre-feet (136.8 million gallons) would be necessary to achieve the Zero Overflow Objective. The cost of the storage was estimated as $214.7 million. However, because the additional storage volume would eliminate the need for one of the MIS reinforcements, the difference between the two alternatives was $177.5 million

Given this background, plus MMSD's recent decision to begin the process for preparing a facilities plan for the period 2010 to 2020, what should be the design condition (for conveyance and for storage purposes) that MMSD uses to develop that plan? From the Department's perspective, the most appropriate design condition for storage purposes is the event in June 1940 that was used to develop the 1980 MFP. We base this conclusion on the following considerations:

1) The June 1940 event was accepted by EPA and DNR as being suitable for sizing facilities needed to comply with the SSO prohibition in MMSD's permit.

2) The five-year storm was not the basis for upgrading MMSD's system under the requirements of the 1977 Dane County Stipulation. In Section F.3. of the Stipulation, MMSD agreed to accept permits reissued by DNR that contain effluent limitations "…which shall require that all discharges from the sewerage systems and treatment plants owned and operated, either individually or collectively, by the Commissions be eliminated by July 1, 1977 or meet secondary and applicable water quality related treatment standards by that date."

3) The Department's approval of MMSD's 2010 Plan did not change the SSO prohibitions in MMSD's permit. The SSO prohibition can only be changed via a modification to or reissuance of MMSD's permit.

4) The requirements of NR 110.05, Wis. Adm. Code, that do not allow DNR to approve sewer extensions tributary to sewerage systems that have SSOs resulting from storms less severe than a five year storm, are intended to create an additional incentive for communities to prevent SSOs and do not represent a design standard for meeting SSO requirements. This conclusion is supported by NR 110.05(7) which states: "…overflows, which result in violations of WPDES permits or court orders and judgments, may still result in enforcement action, notwithstanding a favorable

[8] The 5-year storm in the MMSD service area has the following characteristics: total precipitation (ppt.) after 1 hr = 1.7 in.; ppt. after 6 hrs = 2.3 in.; ppt. after 12 hrs = 2.6 in.; ppt after 24 hrs = 3.1 in.; ppt. after 36 hrs = 3.4 in.

> determination regarding future sewer extensions. The 5-year storm frequency does not represent a criterion for determining compliance with effluent limitations."

The Department also recognizes that changes may eventually occur to the Clean Water Act, EPA regulations, or DNR rules that could change this analysis. If such changes do occur, the Department realizes the design conditions for the purposes of the 2020 Plan would need to be adjusted accordingly.

U.S. EPA Involvement

U.S. EPA-Region 5 in Chicago has been involved in dealing with sewer overflows in the Milwaukee area since the mid-1970s. In 1981, Region 5 and DNR approved MMSD's Master Facilities Plan after preparing a comprehensive Environmental Impact Statement on that plan. Region 5 was also extensively involved in the implementation of that plan during the 1980s and awarded to MMSD over $400 million in grants for construction of projects identified in the MFP.

MMSD, U.S. EPA and DNR officials have been meeting for the past 9 months to discuss the implications of and suitable responses to SSOs in MMSD's service area. Regarding CSO, U.S. EPA has stated that a final determination on the appropriateness of the permit requirements needs to be made based on water quality considerations. Based on suspected impacts to recreational swimming areas, U.S. EPA believes that the permit conditions will most likely need to be strengthened. They also agree that the SSO prohibition, and the analogous prohibition in the general permit for the tributary communities, is consistent with the Clean Water Act, however the "unscheduled bypass" prohibition (both with respect to bypass and SSO) is not consistent with the Clean Water Act and federal regulations. Because the effect of this inconsistency is ambiguous, U.S. EPA has indicated that, in order for permits to be consistent with the Clean Water Act, they need to clearly prohibit all SSOs.

While U.S. EPA has indicated that some enforcement discretion may be appropriate when determining compliance with the SSO prohibition in instances where widespread flooding has occurred, U.S. EPA also believes that MMSD and the communities in its service area need to make commitments to improve the performance of the local systems and regional system so that applicable requirements of the Clean Water Act are fully satisfied. Given this background, it is important to continue to work closely with U.S. EPA to ensure that the new permit issued to MMSD in 2002 is consistent with promulgated federal regulations and the federal Clean Water Act, and meets with U.S. EPA's approval.

Bypassing Reports In Wisconsin

Last 5 Years

Table 1 below provides a summary of selected parameters relating to SSO events on a statewide basis for the period January 1996 through December 2000. Table 1 shows that during the period 1996 through 2000 the number of communities in Wisconsin reporting SSOs ranged from approximately 87 to 123 per year with an average of 99 communities reporting SSOs each year. Also during this period, the Department received notifications reporting an average of 155 SSOs per year statewide. The number of overflows caused by reported "sewer failures" ranged from approximately 43 to 70 occurrences per year with an average of 59 occurrences per year. The number of overflows caused by infiltration/inflow ranged from 65 to 121 occurrences per year with an average of 96 occurrences per year. The estimated annual volume of sewage bypassed during this

period ranged from approximately 182 million gallons in 1998 to approximately 348 million gallons during 1999. Additional details regarding these overflows for each DNR Region and each year from 1996 through 2000 are summarized in Tables 2 through Table 5. Appendix B contains a list of the names of communities that reported SSO caused by I/I between 1996 through 2000, and the years that the SSO event occurred.[9]

Table 1
Statewide Summary Of SSO Events -- 1996 – 2000

	Range of Annual Values	Average Annual Value
No. of Communities Reporting Overflows Each Year	87 – 123	99
Total No. of Reported Overflow Events Each Year	131 – 174	155
No. of Overflow Events Caused by Sewer Failure Each Year	43 – 70	59
No. of Overflow Events Caused by I/I Each Year	65 – 121	96
Approx. Volume of Sewage Overflow Each Year (million gallons)	183 – 348	262

Table 2
Number of SSO Events Caused by I/I
1996 to 2000

Year	NER	NOR	SCR	SER	WCR	Statewide
1996	20	2	36	39	9	105
1997	7	2	3	49	4	65
1998	19	0	25	40	4	89
1999	90	5	25	67	4	101
2000	3	2	31	69	16	120
Avg. for	13	3.8	24	34.4	7.4	96

[9] This information is provisional at this time. Additional information is being collected to verify the data in this Appendix.

Period						

Table 3
Number of SSOs Events Caused by Sewer System Failures
1996 to 2000

Year	NER	NOR	SCR	SER	WCR	Statewide
1996	9	9	34	12	4	68
1997	3	10	25	18	10	66
1998	5	9	19	31	6	70
1999	9	7	11	8	8	43
2000	4	8	22	7	6	47
Avg. for Period	6	8.6	22.2	15.2	6.8	58.8

Table 4
Number of Communities Reporting SSO Caused by I/I
1996 to 2000

Year	NER	NOR	SCR	SER	WCR	Statewide
1996	17	2	31	31	9	90
1997	6	2	2	34	3	47
1998	15	0	19	23	3	60
1999	0	4	24	26	3	57
2000	3	2	21	29	13	68
Avg. for Period	8.2	2.0	19.4	28.6	6.2	64.4

Table 5
Approximate Reported Amount of SSO
1996 to 2000
(in millions of gallons)

Year	NER	NOR	SCR	SER	WCR	Statewide
1996	30.52	0.68	64.99	117.09	2.95	216.23
1997	13.15	0.08	0.52	312.70	2.89	329.34
1998	56.08	0.08	15.40	108.07	2.88	182.50
1999	0.04	2.41	14.79	330.11	0.32	347.57
2000	0.44	0.05	51.71	176.66	2.62	203.66
Average for Period	20.05	0.66	29.48	208.93	2.3	242.3

In reviewing these tables, it is important to note that there are 665 communities that own and operate a treatment plant and sewer system. There are also 232 communities that own and operate a sewer system that is tributary to a regional sewage treatment plant and are covered by the general permit that applies to such systems. The total number of communities, therefore, that could report SSOs caused by I/I each year is 897. From 1996 through 2000, 162 different communities, or about 18% of 897, reported SSO due to excessive I/I in their collection systems. However, during the past five years, the average number of communities reporting SSO on an annual average basis is about 99, which is 11% of the total number of communities with sewage collection systems.

Statewide Strategy for SSO/CSO

Given this background and the detrimental effects of SSO and CSO, the Department intends to carry out the following activities, to minimize the frequency and volume of SSO and CSO discharged throughout the state:

Identify and Inventory All SSOs

All sanitary sewer overflows are required, as a condition of a WPDES permit, to be reported to the Department. These reports are being received and catalogued. A more detailed review of Department records showed that reporting needs to be more timely, complete and accurate. The compilation of reported SSOs will be used as the starting point for the following actions by the Department:

1) Define the type of discharges that fall under the scope of the inventory.

2) Review, for calendar years 1996 through 2000, and revise as necessary, the existing list of overflows. Publish an updated and complete inventory.

3) Refine and improve the existing internal reporting system and database for SSO information.

4) Identify, review and revise, as necessary, any existing guidance concerning the reporting of SSOs.

General Permit

A general WPDES permit has been issued to regulate discharges from sanitary sewer systems that are connected to another municipality's collection and treatment system. This permit expires March 31, 2001. At least 222 sewer collection systems in Wisconsin are regulated under the provisions of this permit. To insure consistent documentation of and follow-up for SSOs throughout the state, the following actions are needed:

1) Reissue the general permit "Applicable to Bypasses and Overflows of Sewage for Tributary Sanitary Sewer Systems" as soon as possible.

2) If frequent SSOs are occurring in a municipality, consider the issuance of a system-specific permit to that municipality to assure that specific needed follow-up actions are taken.

Enforcement Follow-up for SSOs

Action to prevent SSOs has, in the past decade, been primarily driven by the "sewer extension ban" provisions of s. NR 110.05, Wis. Adm. Code. In addition, when a community prepares a facility plan for treatment plant expansion or improvements, they must evaluate I/I to assure plant capacities are sufficient to handle all sewage in the system or reduce sources of I/I. In recent years, violations of the overflow requirements in discharge permits have been addressed through formal discussions and agreements with the permittee, rather than initiating a formal enforcement action. Given the frequency and volume of SSOs being reported, the following Department actions are now needed:

1) Review existing SSO enforcement guidance. Prepare a historical record of corrective actions taken in response to SSO events.

2) Revise enforcement guidance related to SSO discharge events, placing emphasis on assuring a prompt initial response occurs to all SSO events to determine the scope of the problem and corrective follow-up actions. Include in the revised guidance a process for determining whether an SSO was authorized or not authorized by the applicable permit.

3) Develop internal procedures to assure uniform and consistent application of the revised guidance throughout the state.

Communication and Outreach

To facilitate the updating of DNR's inventory of SSOs, continued communication among Department staff and municipal officials and consultants is needed. This outreach will also help assure that municipal officials fully understand the SSO requirements in their permit and the options that are available for meeting those requirements. To this end, the following actions will be implemented:

1) Hold workshops, attend conferences, and use written instructions to communicate to municipalities the importance of the SSO requirements in their permit.

2) Work with municipal officials, consultants, equipment vendors, etc., individually or via various member organizations (e.g., Wisconsin Section-Water Environment

Federation, Wis. Wastewater Operators Association) to communicate Department policy relative to SSO.

CSO Policy Evaluation

U.S. EPA published the national CSO policy in 1994. Due to Wisconsin's long-standing commitment to phase out such systems, only three CSO systems exist in the state. Therefore, the use of EPA's policy in Wisconsin has limited applicability. Because primary issues regarding CSO are associated with the Milwaukee system, follow-up actions for that system are specified later in this report.

Water Quality and Effluent Quality Studies – Milwaukee Area

The Milwaukee Metropolitan Sewerage District and other agencies and organizations have monitored water quality in area waterways for many years. To gather information to help determine if the CSO control level currently available is sufficient to achieve applicable water quality standards, MMSD's discharge permit requires periodic monitoring of area waterways during and following CSO events and during dry weather periods. The relationship between various point and nonpoint sources of pollution and the effects on water quality have not been fully evaluated and determined. In addition, the Department has identified, as a result of the several recent overflow events, a need to characterize water quality more accurately, particularly related to microbial pathogens. Follow-up actions that are needed include:

1) Work with MMSD and other agencies and organizations to summarize available data related to causes and effects of water quality impairment in the Milwaukee River, the Menomonee River, the Kinnickinnic River, the affected tributaries of the three rivers, and Lake Michigan.

2) Continue to monitor and evaluate water quality in area waters and review data resulting from these surveys. Review and revise existing programs and permit conditions during the reissuance of MMSD's permit in 2002 to assure data collection activities will result in sufficient information to determine what level of CSO control and control of other sources of water quality impairment will be needed to attain applicable water quality standards. Any such determination will need to factor in the relative effects of all sources of impairment to water quality.

3) Complete the investigation of microbial pathogens and other water quality indicators in the Milwaukee River and environs as planned under the U.S. EPA grant.

4) Work with MMSD to conduct a study from April 2001 through September 2001 to determine what testing frequency and what testing time (or times) for collecting samples for fecal coliform in the effluent from the Jones Island and South Shore treatment facilities provides data that is sufficiently representative of these discharges. Work with MMSD to determine the minimum testing frequency that will be used during the study and to assure that MMSD's discharge permit (to be reissued in 2002) includes provisions consistent with the results of the study.

Pilot Watershed Project

In addition to sanitary and combined sewer overflows, the Milwaukee River and nearby Lake Michigan are impacted by rural and urban stormwater runoff and other point sources. The "watershed approach" is designed to holistically evaluate causes and effects of water quality impairment and prioritize actions that will lead to improvement. The use of a

watershed approach is one element of EPA's rule-making efforts for SSOs (see next section). Information about the levels of several pollutants that are typically present in SSO, CSO, stormwater and area waterways prior to and after precipitation events is contained in Appendix A. Follow-up actions include:

1) Within the Milwaukee River Basin, evaluate, with other appropriate stakeholder groups, the application of a watershed approach to managing CSOs and SSOs, stormwater and other sources that impair water quality.

2) Incorporate the elements identified in item 1 above into the Department's "State of the Basin Report" for the Milwaukee River basin.

Federal Rules Process

U.S. EPA is developing revisions to federal regulations applicable to SSO discharges. These proposed regulations address many of the issues discussed in this report. U.S. EPA's current timetable envisions publication of proposed regulations in 2001, pending internal administration review. Follow-up actions include:

1) Closely monitor EPA's progress in adopting these regulations. Provide comment during the process.

2) Incorporate EPA's regulatory requirements into state rules and operating procedures, as appropriate.

Rulemaking and Compliance Maintenance

Existing rules related to SSO and in-plant diversions, are located in different chapters and sections of the Wisconsin Administrative Code (e.g., chs. NR 102, NR 110, NR 205 and NR 208). The administrative, regulatory and enforcement mechanisms in these different chapters vary depending on their respective statutory authorizations, which can result in inconsistent application of these requirements. The definition of similar terms differs from rule to rule creating even greater confusion. These rules also need to be reviewed to assure they are consistent with applicable statutory requirements and federal regulations, are consistent with each other and provide the design bases that are needed for sewerage system construction. In developing new or revised rules, risk management decisions will need to be made regarding the various sources of water quality impairment, the respective water quality improvements that controls may bring, and the costs associated with attaining any improvements in water quality.

The Compliance Maintenance program (ch. NR 208, Wis. Adm. Code) requires all owners of publicly owned treatment systems to evaluate their treatment facility annually to assure it will be operated and maintained in a manner to "…avoid water quality degradation and prevent violations of WPDES permit effluent limits." Although there is a similar reference to sanitary sewer systems in the rule, there is no direct requirement to assure that these systems are maintained and operated in a manner to prevent SSOs. EPA, in its draft regulations, is proposing to require all such sanitary sewer systems to implement a capacity, management, operation and maintenance program to assure communities are appropriately evaluating their sanitary sewer systems. Given this background, the following actions are needed:

1) Create a single rule or an appropriately cross-referenced set of rules, regarding sanitary sewer overflows) and sewerage system design that fully and consistently integrate the provisions of chs. NR 110, NR 205, NR 208, NR 210, etc and satisfy relevant federal requirements.

2) Expand the Compliance Maintenance program to include municipalities that have sewer systems that discharge into another municipality's collection and treatment system.

3) Incorporate the federal Capacity, Management, Operation and Maintenance concept into the state's Compliance Maintenance program.

Milwaukee Metropolitan Sewerage District - Next Steps

Regarding the SSOs and CSOs in the MMSD service area, where do we go from here and how do we get there? MMSD certainly has a state-of-the-art system. It has greatly reduced the frequency and volume of SSO and CSO discharges. A similar level of SSO and CSO control occurs in few, if any, metropolitan areas of more than one million people in the United States. The District currently has underway a significant number of projects that will move them forward in meeting Clean Water Act requirements including, as noted earlier: 25 relief sewer projects, treatment plant modifications, control and information system modifications and other improvements that are recommended in the 2010 Facilities Plan ($350 million); completion of the Flood Management Program (to keep floodwaters from entering sanitary sewers thus reducing I/I; $250 million); completion of programs to reduce I/I ($17 million); and an overhaul of the central Metropolitan Interceptor System ($350 million). These expenditures are planned over the next six to eight years.

However, periodic SSOs from MMSD's system and tributary community systems continue to occur. While some of these SSOs have resulted from storm events more severe than the "design storm" used in 1980 to develop the Master Facilities Plan (1980 MFP) for upgrading MMSD's system, there were many occasions when less severe events have resulted in SSO. In addition, the decision in August 1999 to reserve 200 million gallons of ISS capacity for SSOs (instead of 50 million gallons) may have increased the amount of CSO discharged on several occasions.

SSO discharges are not authorized by MMSD's permit and the general permit applicable to communities tributary to MMSD, unless the discharge was due to equipment damage or power interruption, was necessary to protect life and property, or was caused by excessive storm drainage or runoff. SSO discharges that are caused by infiltration/inflow (I/I) are primarily the result of water that enters sewer systems owned by communities in the MMSD service area. Since 1994, MMSD has reported a total of 13 events during which a total of 165 locations discharged SSO that resulted from the ISS being filled to capacity. In addition, during 9 events there were 13 locations that discharged SSO from the Metropolitan Interceptor System (MIS) because of insufficient conveyance capacity downstream from the SSO discharge location.

It is important to point out that excessive I/I originates in the sanitary sewage collection systems of the individual communities in the MMSD service area. Therefore, even though the SSO occurs from discharge points in the MMSD's interceptors, the individual communities within MMSD's service area will play a significant role in future work to prevent SSOs.

Appendix C presents information about SSOs from the ISS that have been reported since 1994 and the Department's preliminary assessment (based on currently available information) of each of the 13 SSO events that have occurred. Appendix C indicates that there have been 8 events since 1994 during which SSO was discharged at a total of 102 locations and that such discharges may

not have been authorized by MMSD's permit.[10] The total amount of precipitation, its intensity and area of coverage during these 10 events did not exceed the "design storm" that was the basis for the 1980 MFP.[11] During 6 of these 8 events, the 5 year storm[12] covered 25% or less of the MMSD service area. During the other 2 events, the coverage level was approximately 33% and 50%, respectively. Appendix D provides a summary of the storm characteristics associated with each of the 13 events with SSOs from the ISS.

Appendix C also indicates that the SSO events on June 20, 1997 and August 5, 1998 were authorized by MMSD's permit due to the amount of precipitation, its intensity and area of coverage. In addition, there were 3 events that, due to their unique characteristics, will require more analysis to determine which SSOs were (and were not) authorized by MMSD's permit. More analyses will also be needed for 9 SSO events that were not ISS related.

Appendix B, as it relates to SSOs from communities in MMSD's service area, indicates that a total of 17 communities reported a total of 129 SSO events between 1996 and 2000. A detailed analysis of these events is being conducted to determine which events were not authorized by the general permit applicable to these communities. A preliminary analysis of these events suggests that some may not have been authorized by the general permit. To regain consistent compliance with that permit, the interconnectedness of the MMSD system with the sewer systems that serve each of the tributary communities requires that I/I sources be identified and solutions be implemented on a system-wide basis. In addition, the individual communities must maintain, operate and manage their sewer systems so that I/I is minimized to the extent practicable in order to prevent unauthorized discharges of SSO.

System Operational Adjustments and Upgrades

Given this background, in the near term it is recommended that MMSD continue to evaluate a variety of operational adjustments and system upgrades to determine their feasibility for reducing the frequency and volume of SSO and CSO discharges.[13] In addition to these operational adjustments, it is recommended that several facility upgrades currently underway be completed as

[10] This is a preliminary determination that will require further dialogue with MMSD about each event in terms of its intensity, duration, area of coverage, when it started, what outfalls were active and for how long the discharge lasted, etc.

[11] This "design storm" assumed uniform distribution of a rainfall event with the following characterization: total precipitation (ppt.) after 1 hour = 1.2 inches, total ppt. after 6 hours = 3.2in., total ppt. after 12 hours = 3.9 in., total ppt. after 24 hours = 4.7 in., and total ppt. after 36 hours = 5.3 in.

[12] See footnote 8 on page 29 for description of the 5-year storm.

[13] If current practices have already optimized performance, MMSD will supply information to DNR documenting the improved system performance and how the system has been optimized.

soon as possible. The operational adjustments to be considered and the facility upgrades to be completed include:

1) Maximize the use of the in-plant diversion around the secondary treatment system at Jones Island as soon as SSO and/or CSO becomes tributary to the ISS and continue that practice until it becomes apparent that the SSOs and CSOs generated by the event can be fully captured by the ISS.

2) Complete renovations currently underway at South Shore to increase preliminary and primary treatment capacity and to eliminate hydraulic bottlenecks, thereby allowing in-plant diversions around the secondary system during SSO or CSO events.

3) Increase the capacity of the primary system at Jones Island and South Shore through operational enhancements, so that during events when SSO or CSO is tributary to the ISS more sewage can receive primary treatment and disinfection.

4) Increase the capacity of the secondary system at Jones Island and South Shore through operational enhancements so that during SSO or CSO events more sewage can receive secondary treatment.

5) Continue to explore methods to maximize the current capability to store sewage in the South Shore Interceptor as soon as it appears that the ISS may be needed to accept SSO or CSO and continue that practice until it becomes apparent that the SSOs and CSOs generated by the event can be fully captured by the ISS.

6) Continue to explore the feasibility implementing operational adjustments that enable more sewage to be temporarily stored in various segments of the MIS as soon as it appears that the ISS may be needed to accept SSO or CSO and continue that practice until it becomes apparent that the SSOs and CSOs generated by the event can be fully captured by the ISS.

7) Increase the diameter of new relief sewer projects beyond that needed solely for conveyance purposes, thereby allowing sewage to be stored in such interceptors during events when SSO or CSO is tributary to the ISS.

8) Accelerate efforts to reduce, as soon as possible, sewage flows during storm events from the 287 separated sewer basins that have peak to base flow ratios greater than 6 to 1. This work should take into consideration the results of ongoing I/I removal demonstration projects initiated under the 2010 facilities plan.

9) Complete the installation of the new instrumentation and control project identified in the 2010 facilities plan, so that more real-time data is available to adjust operational parameters for Jones Island, South Shore and the ISS in order to maximize the capture of SSO and CSO and minimize discharges to area waterways.

10) Finalize work to create a single, comprehensive database that provides a daily inventory of inputs to and outputs from the ISS, Jones Island and South Shore. Examples of information to be included in the database are: SSO and CSO volume captured by the ISS, SSO and CSO volume not captured by the ISS, SSO volume not captured by the MIS, ISS pumpout to Jones Island (primary and/or disinfection) and South Shore, and sewage volume treated at Jones Island and South Shore including the volumes that receive primary treatment, secondary treatment and disinfection.

11) Evaluate the feasibility of any other operational changes not listed above that may be identified in the future by MMSD or DNR.

Given the potential benefits of the operational adjustments listed above, the Department will work with MMSD over the next six months to explore their feasibility. After that, the Department will work with MMSD to develop a report to identify the adjustments that warrant additional follow-up and what the scope and timeline should be for the resulting implementation projects.

Long-term Projects and Activities

In the long term, for MMSD and the tributary communities to regain full compliance with the SSO provisions in their permits, further work will be needed to determine how much additional I/I can cost-effectively be removed and how much I/I must be conveyed to and treated by MMSD. Given MMSD's previous experience with upgrading its system between 1980 and 1994, it will take at least 10 years to gather information, evaluate options, design projects and construct facilities needed to meet applicable permit requirements for all storm events less severe than the "design storm" used as the basis for the 1980 MFP.

How can sufficient assurances be provided so that all work needed to meet applicable permit requirements will be completed as soon as practicable? Fortunately, there are some options available. Ultimately, which one (or ones) are used will depend on a variety of factors that reflect the perspectives and needs of MMSD, the tributary communities, EPA, the public and DNR. At this time, the options that warrant further consideration and discussion are as follows:

1) Include appropriate provisions (deadlines and deliverables) in MMSD's permit when it's reissued next year to replace the current permit that expires on March 31, 2002.

2) Amend the Dane County Stipulation to include appropriate provisions.

3) Enter into a judicial or administrative agreement involving MMSD and the tributary communities with SSO to establish appropriate provisions.

From DNR's perspective, to assure all SSO requirements are met as soon as possible and the discharge of CSO is minimized, the following actions will be discussed with MMSD for consideration for inclusion in the implementation approach that is ultimately selected:

1) Submit a plan to DNR by September 30, 2002 for upgrading the MIS flow monitoring network by March 31, 2004 to assure that adequate sewage flow data is available for approximately 75% of the total flow from separated sewer basins tributary to the MIS during major storm events. The plan for upgrading the MIS monitoring network would also include expansion of the MMSD rain gauge network to include additional locations in Mequon, Germantown, New Berlin, Franklin and Oak Creek.

2) Adopt, by December 31, 2005, a facilities plan for the MMSD service area for the period 2010 to 2020. This plan would be based on a cost-effectiveness analysis of existing I/I sources that determines, for each basin in MMSD's service area, what I/I sources should be removed (or reduced), and to the extent not removed (or reduced), what facilities MMSD will construct to convey, store and/or treat the remaining I/I.

3) Base the 2020 facilities plan on the storm event that served as the design basis for the 1980 MFP, while still providing an average of no more than 2 CSO events per year. In the event that EPA or DNR:

   a) Adopt regulations prior to December 31, 2005 and those regulations allow for a less severe storm event than the one used in the 1980 MFP, appropriate adjustments[14] would be made to the deadline in item 2, the design storm in item 3, and the deadlines in item 4. Any disputes about the adjustments that are warranted in items 2, 3 and 4 would be resolved using a mutually agreeable mechanism, or,

   b) Adopt regulations that take effect after December 31, 2005 and those regulations allow for a less severe event than that used in the 1980 MFP, appropriate adjustments[14] would be made to items 3 and 4. Any disputes about needed adjustments would be resolved using a mutually agreeable mechanism to the extent deadlines or content relief is still relevant, or,

   c) Adopt regulations that take effect after the date of this report and those regulations require the use of a storm event more severe than the one used in the 1980 MFP, appropriate adjustments[14] would be made to items 3 and 4. Any disputes about needed adjustments would be resolved using a mutually agreeable mechanism.

4) Complete any upgrading of MMSD's system delineated in the 2020 facilities plan by March 31, 2012 and adopting rules by December 31, 2006 that require the tributary communities to complete by March 31, 2012 all work required by the rules. These

[14] These adjustments would include those needed to meet applicable water quality standards and any other applicable requirements.

rules would be based upon and require compliance with the I/I cost-effectiveness analysis for each community in the 2020 facilities plan. These rules would include sufficient interim deadlines to assure each community makes reasonable progress each year towards completing all their work by March 31, 2012.

5) Achieve a minimum annual expenditure level[15] for each year during the ten year period beginning January 1, 2002 for the 2010 plan and subsequently, for the 2020 plan, unless:

   a) All necessary MMSD work and local community work is completed sooner, or,

   b) The Department agrees to a lower figure for a given year based on a demonstration by MMSD that all the MMSD and local community work will still be completed by March 31, 2012.

6) Submit to DNR each year (starting in 2002):

   a) A master program schedule that shows all planning, design and construction projects that must be initiated each year between 2002 and 2012 to complete the upgrading of its system by March 31, 2012, and

   b) The list of design and construction projects to be awarded each year that are consistent with the Master Program Schedule and are needed to meet minimum annual expenditure levels.

   c) Any disputes about a project (or lack thereof) in the Master Program Schedule (or on the annual project list), or the start (or completion) date for a project would be resolved using a mutually agreeable mechanism.

7) If items 1 through 6 are implemented via MMSD's permit that is reissued in 2002, then MMSD would agree to accept the carryover of items 4, 5 and 6 into MMSD's permit that would be reissued in 2007. However, the reasonableness of the March 31, 2012 deadline may be challenged by MMSD after the permit is reissued. Such a challenge would not postpone the application of items 5 and 6.

Department of Natural Resources – Next Steps

This report presents some interesting information about separated sewer overflows in Wisconsin. On the one hand, during the past 5 years, an average of 96 communities per year reported SSO events caused by I/I. However, that is just 11% of the 897 communities that could report SSO. While we recognize that some communities may not yet have reported all instances of SSO, current information indicates that approximately 18% of Wisconsin communities have reported one or more SSO events in the past 5 years caused by I/I.

To reduce the frequency and volume of SSOs, Chapter IX (Statewide Strategy for SSO/CSO) and Chapter X (Milwaukee Metropolitan Sewerage District – Next Steps) of this report highlight a number of topics that require additional attention and follow through. Many of the recommendations in this report will require the cooperative efforts of local,

[15] The exact amount would be determined after further consideration of a variety of factors including the estimated total cost of upgrading MMSD's system to meet applicable permit requirements. For comparison purposes, the 1977 Dane County Stipulation had two different minimum annual expenditure requirements (both expressed in 1976 dollars) of $13 million per year for CSO work and $15 million per year for non-CSO work.

county, regional, state and federal governmental units to implement. The Department is committed to facilitating that cooperation as these initiatives move forward.